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Paper on Basics of Internet of Things

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Abstract
The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human intervention. This paper focuses on different aspects of IOT - Definition, challenges, Objectives, Communication Models and Applications of IOT.
Keywords: *Internet Of Things, Smart Objects, Communication Models, Sensors, Percepion, Intelligent Service.*

Introduction

The term "Internet of Things" (IOT) was first used in 1999 by British technology pioneer Kevin Ashton to describe a system in which objects in the physical world could be connected to the Internet by sensors. Many of these devices, often called "smart objects,'' are not directly operated by humans, but exist as components in buildings or vehicles, or are spread out in the environment.
Within the Internet Engineering Task Force (IETF), the term "smart object networking" is commonly used in reference to the Internet of Things. In this context, "smart objects" are devices that typically have significant constraints, such as limited power, memory, and processing resources, or bandwidth.
IOT is not single technology; it's a concept in which most of new things are connected to serve many applications. To accommodate diversity of IOT, there is a heterogenous mix of communication technologies which need to be adapted to address needs of IOT Applicatons such as energy efficiency, security, reliability e.t.c.

Objectives of IoT

Compared with the traditional information networks, IoT has three new goals.

- **More Extensive Interconnection-** IoT extends the interconnection among the information equipments, such as computer and mobile phone, to the interconnection of all intelligent or non-intelligent physical objects.

It has the following outstanding characteristics:

- Extensiveness in the quantity of devices. The amount of the connected devices will sharply rise from several billions to over hundreds of billions, including a multitude of equipments, sensors, actuators, vehicles, and devices.
- Extensiveness in the type of Network ing devices may be powered by the electronic power directly or by batteries; the computation and communication capacity may be greatly different, e.g., some devices even may not have any computational ability.
- Extensiveness in the connection The de vices may be connected in a wired or wireless mode and communication could be a single hop or multiple hop. The connection can be strong state routing or sta- tistical weak state routing.

Thus, in such a large-scale heterogeneous network, we must meet the challenge of highly-efficient interconnection of network elements.

- **More Intensive Information Perception** - IoT extends the paradigm of traditional single sensors that sense the local environment independently to the new paradigm of collaboration of multi-sensors to achieve the global environment awareness.

Sensing information from each single sensor may contain uncertainties in the following aspects:

- Non-uniformity - Data formats for temperature, humidity, audio, video, and other information are different from each other.
- There is inconsistent information due to the distortion of space-time mapping.
- A range of information inaccuracies are often caused by the variety of sampling methods and different capabilities of the sensors.
- Intermittent information availability, partial loss of information is often caused by the dynamic network transmission capacity.
- Incomplete sensing of information is caused by the limitations of sensors. For example, measuring the forest pollution relying on Carbon Dioxide information only is clearly inadequate.

Therefore, it is difficult to use the sensor information directly, and the challenge of effective utilization of the uncertain sensory data in IoT must be met.

- **More Comprehensive Intelligent Service**

Based on the extensive interconnection of ordinary physical objects and the intensive perception of the physical world, IoT can provide comprehensive intelligent services, where physical objects are actively involved in the service process. For example, some networks, like vehicle-carrying networks, human-carrying networks, intelligent transportation networks and en- vironment monitoring networks, can be integrated to provide intelligent services, such as dynamic congestion state, weather condition, environment information, and health condition, thus to achieve the harmony of people, vehicles, roads and environment. They can also dynamically change the travel suggestions, and instruct users to travel reasonably and efficiently. These intelligent services call for new software modelling theories, service delivery mechanisms and methods that can adapt to the dynamic environment of IoT. The conventional software development method is suitable to the two-tuple problem domain consisting of user requirements and cyber space, but is less suitable for the system environment with three-tuple problem domain consisting of user requirement, cyber space and physical space, and it is also hard to provide flexible, suitable and more comprehensive intelligent service. As a new type of network, IoT is characterized by the large-scale heterogeneous network elements, the uncertain sensing information, and the dynamic system environment. These features raise the challenges such as highly efficient interconnection of large-scale heterogeneous network elements, effective utilization of uncertain sensing information and service delivery in the dynamic system environment.

Charecteristics of IOT

- Interconnectivity – With regard to IOT, anything can be interconnected to global information and communication infrastructure.
- Things Related To Services – IOT is capable of providing things related to services with some constraints such as privacy protection and semantic consistency between physical and virtual things, both virtual and physical things may change.
- Heterogenity–Things in IOT areheterogenous based on different hardware platforms and networks.

- Dynamic Changes – State of devices change dynamically example waking/ sleeping, connected/ disconnected, location and speed in case of devices.
- Enormous Scale – number of devices that need tobe managed and that communicate with each other will be atleast in order of magnitude larger than devices that are connected to current internet.

Architecture and Components of IOT

Figure1[6] shows components of a generic IoT system and how they interact. The major components already exist in specific instances and currently companies are competing to become the de facto platform for such devices.

The components are

- Hardware devices that are able to sense and interface with the physical world
- Data collected on the behalf of the user by these devices
- IoT hubs that funnel data from the physical world to the cloud
- An IoT marketplace with value-added apps that interact with devices and the cloud
- Services, large and small, that the apps connect to (could be one or more, could be a vertical device-app-service, or could be stratified)
- Varying sizes of data stores, including federated data stores that normalize data from heterogeneous sources, that the services maintain (collected from the apps and devices)

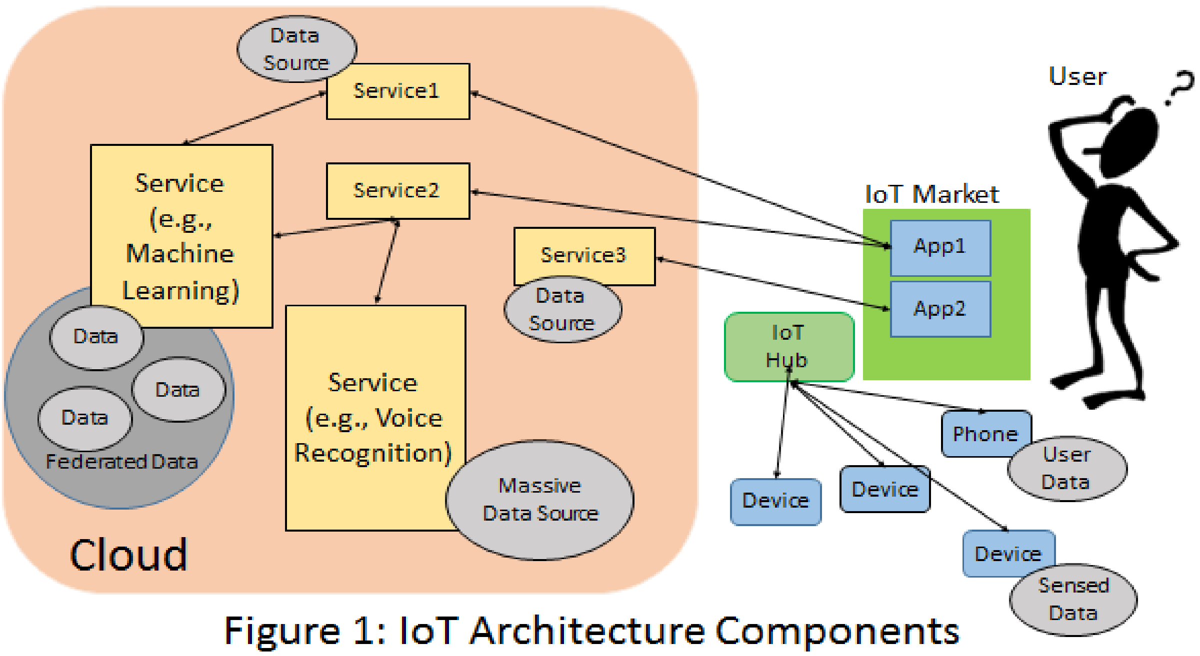

Figure 1: IoT Architecture Components

Internet of Things Communications Models

Networking and communications models [13] for smart objects include those where exchanged data does not traverse the Internet or an IP-based network.

Device-to-Device Communications

The device-to-device communication model represents two or more devices that directly connect and communicate between one another, rather than through an intermediary application server. These devices communicate over many types of networks, including IP networks or the Internet. Often, however these devices use protocols like Bluetooth, 40 Z-Wave, 41 or ZigBee42 to establish direct device-to-device.

This communication model is commonly used in applications like home automation systems, which typically use small data packets of information to communicate between devices with relatively low data rate requirements. Residential IoT devices like light bulbs, light switches, thermostats, and door locks normally send small amounts of information to each other example, a door lock status message or turn on light command

Device-to-Cloud Communications

The IoT device connects directly to an Internet cloud service like an application service provider to exchange data and control message traffic. This approach frequently takes advantage of existing communications mechanisms like traditional wired Ethernet or Wi-Fi connections to establish a connection between the device and the IP network, which ultimately connects to the cloud service.

Example of this is, Samsung *Smart TV* technology, the television that uses an Internet connection to transmit user viewing information to Samsung for analysis and to enable the interactive voice recognition features of the TV. In these cases, the device-to-cloud model adds value to the enduser by extending the capabilities of the device beyond its native features. "vendor lock-in'', a term that encompasses other facets of the relationship with the provider such as ownership of and access to the data. At the same time, users can generally have confidence that devices designed for the specific platform can be integrated.

Device-to-Gateway Model

The device-to-application-layer gateway (ALG) model, the IoT device connects through an ALG service as a conduit to reach a cloud service. In simpler terms, this means that there is application software operating on a local gateway device, which acts as an intermediary between the device and the cloud service and provides security and other functionality such as data or protocol translation.

Several forms of this model are found in consumer devices. In many cases, the local gateway device is a smartphone running an app to communicate with a device and relay data to a cloud service. This is often the model employed with popular consumer items like personal fitness trackers. These devices do not have the native ability to connect directly to a cloud service, so they frequently rely on smartphone app software to serve as an intermediary gateway to connect the fitness device to the cloud.

Back-End Data-Sharing Model

The back-end data-sharing model refers to a communication architecture that enables users to export and analyze smart object data from a cloud service in combination with data from other sources. This architecture supports "the user's desire for granting access to the uploaded sensor data to third parties". This approach is an extension of the single device-to-cloud communication model, which can lead to data silos where "IoT devices upload data only to a single application service provider''. A back-end sharing architecture allows the data collected from single IoT device data streams to be aggregated and analyzed.

For example, a corporate user in charge of an office complex would be interested in consolidating and analyzing the energy consumption and utilities data produced by all the IoT sensors and Internet-enabled utility systems on the premises. Often in the single device-to-cloud model, the data each IoT sensor or system produces sits in a stand-alone data silo. An effective back-end data sharing architecture would allow the company to easily access and analyze the data in the cloud produced by the whole spectrum of devices in the building. Also, this kind of architecture facilitates data portability needs. Effective back-end data sharing architectures allow users to move their data when they switch between IoT services, breaking down traditional data silo barriers.

Applications of IOT

Fundamentally, the Internet Society cares about the IoT as it represents a growing aspect of how people and institutions are likely to interact with the Internet and transform the way they work, live and Play in their personal, social, and economic lives.

From building and home automation to wearables, the IoT touches every facet of our lives, it makes developing applications easier with hardware, software and support to get anything connected within the IoT.

- Building & Home Automation-Access Control, Light & Temperature Control, Energy Optimization, Predictive Maintainance, Connected Appliances.
- Smart Cities - Pipe Leak Detection, Traffic Management, Smart Street Lights, Residential E-Meters, Survialence Cameras, Centralized and Integrated System Control.
- Wearables - Fitness, Smart Watches, Entertainment, Location & Tracking.
- Healthcare – Remote Monitoring, Drug Tracking, Ambulance Telemetry, Hospital Asset Tracking, Predictive Maintainance.
- Automotive – Wire Replacement, Telemetry, Car to Car and Infrastructure, Predictive Maintainance.
- Smart Manufacturing – Real time Inventory, Employees Safety, Firmware Updates, Flow Optimization, Predictive Maintainance.
- Agriculture – Automatic Weather Forecast, Improve the Yeild,Plan Irrigation, Monitor Crop Nutrients.
- Smart Grids - Use of information about the behaviors of electricity suppliers and consumers in an automated fashion to improve the efficiency, reliability, and economics of electricity.

IOT Applications will not end up it touches every fact of our lives – Smart Roads, Smart Parking, Smart Lightening, Smart Phone Detection, Traffic Congestion, Waste Management, Air pollution, Early Earth Quake Detection, Forest fire Detection, Swimming pool Remote Measurement e.t.c.

Conclusion

In conclusion, Internet of Things is the concept in which the virtual world of information technology connected to the real world of things. The technologies of Internet of things such as RFID and Sensor make our life become better and more comfortable. Most of the necessary technological advances needed for it have already been made, and some manufacturers and agencies have already begun implementing a small-scale version of it. The main reasons why it has not truly been implemented is the impact it will have on the legal, ethical, security and social fields.

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